

AERIAL SURVEYS OF BELUGAS IN COOK INLET, ALASKA, AUGUST 2011

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Abstract—The National Marine Fisheries Service (NMFS) conducted an aerial survey of the beluga population in northern Cook Inlet, Alaska, 9-11 August 2011. The goal of the surveys was to obtain high-resolution video of each group of belugas to determine age structure (white relative to gray individuals and dark gray calves) and number of calves. The survey (12.3 hours total) covered the coastal areas north of Point Possession and Beluga River. Consistent with previous surveys by NMFS made each year since 1993, the August 2011 survey was flown in a high-wing, twin-engine aircraft (AeroCommander 690 *N222ME*) at an altitude of 244 m (800 ft) and a speed of 185 km/hr (100 kt). The survey track paralleled the coast (1.4 km offshore) and surveys occurred during the low tide when possible. Beluga groups were found in the Susitna delta (from the Beluga River to the Little Susitna River) and in Knik Arm every day. On the 9 August survey, we video-taped and/or counted 5 beluga groups: two groups traveling from Susitna River toward the Little Susitna River (median counts = 13 and 158), a group in the mouth of the Little Susitna River (median count = 19), a group traveling from the Little Susitna River toward Point Mackenzie (median count = 18), and a group in Eagle Bay headed toward Eagle River (median count = 9) for a total median count of 204. On the 10 August low tide, we coordinated efforts with LGL's boat-based photo-identification project and joint base Fort Richardson/Elmendorf Eagle Bay survey team, counting and video-taping a beluga group then alerting the teams to the group to begin their photo-id effort after we departed the area to find another group. Belugas were again in Eagle Bay (median count = 25) and the Little Susitna River (median count = 41), and along the east tributary of the Susitna River (possibly as many as 4 groups). Unfortunately, due to groups traveling rapidly back and forth across the Susitna River mudflats, merging and splitting and concern of repeat sampling of groups, a total median count was not calculated for 10 August. On the 11 August low tide, we video-taped and/or counted 6 beluga groups: three along the Susitna River mudflats (median counts = 7, 57 and one large, rapidly travelling group), one large group milling west of the mouth of the Little Susitna River, one small group swimming toward Point Mackenzie (median count = 4), and one group in Eagle Bay (median count = 55). Median counts of the larger groups were potentially compromised by whale behavior (i.e., rapid swim speeds, multi-directional surfacing), therefore, a total median count for the day will await analyses of the video. We saw no belugas in Chickaloon Bay or Turnagain Arm during this survey. The median estimate of belugas seen on 9 August 2011 (a quick index of relative abundance not corrected for missed whales) was similar to counts in 2010 (128 on 17 August, 154 on 18 August, and 266 on 19 August), 2009 (196 on 11 August, 212 on 12 August, and 197 on 13 August), 2008 (109 belugas on 12 August, 177 on 13 August, 194 on 14 August), 2007 (181 belugas on 1 August, 141 belugas on 2 August), 2006 (126 belugas on 16 August, 143 belugas on 17 August), and 2005 (236 belugas on 11 August, 277 belugas on 12 August).

Introduction

The National Marine Fisheries Service (NMFS) conducts aerial surveys of belugas (*Delphinapterus leucas*) in Cook Inlet, Alaska, each year to document their local distribution and abundance (Rugh et al. 2000, 2005a). This project is in cooperation with the Cook Inlet Marine Mammal Council (CIMMC) and the Alaska Beluga Whale Committee (ABWC). Management concerns have focused on the population of belugas in Cook Inlet because of its isolation from other beluga populations (O’Corry-Crowe et al. 1997; Laidre et al. 2000; Rugh et al. 2000) and its small size (<400 whales; Hobbs et al. 2000a; Hobbs and Shelden 2008). The population in Cook Inlet has been designated as *depleted* under the Marine Mammal Protection Act (MMPA, 65 FR 34590) and as *endangered* under the Endangered Species Act (73 FR 62919, October 22, 2008). The subsistence hunt by Alaska Natives has been managed under MMPA Section 119 (Cooperative Agreements with NMFS) since 2000 (65 FR 59164, Mahoney and Shelden 2000).

The goals of the aerial survey in August 2010 were a) to document seasonal distribution relative to temporal habitat features (e.g. fish runs) and, b) to use paired high-definition (HD) video cameras to document the age structure of groups of belugas (white relative to gray individuals and dark gray calves) in Cook Inlet at a time when most calves have been born. This is the sixth year for this project which began in August 2005 (Rugh et al. 2005a, 2006; Shelden et al. 2007, 2008, 2009). We also took this opportunity to continue testing our aerial counts and videotaped results of specific beluga groups against results from LGL Alaska Research Associates, Inc., boat-based photo-identification project, an experiment first undertaken in August 2009 (Shelden et al. 2009).

Methods

The survey aircraft (AeroCommander, *N222ME*), was equipped with large bubble windows at the left and right forward observer positions. Video camera footage was obtained through a large flat window on the back left. An intercom system allowed communication among the observers, data recorder, and pilots. A computer program recorded sighting and location data from a portable Global Positioning System (GPS). Data entries included routine updates of time, location, percent cloud cover, sea state (Beaufort scale), glare (on the left and right), visibility (on the left and right), and start and stop of survey effort. Visibility was documented using five subjective categories from *excellent* to *useless*. Survey segments that were rated as *poor* or *useless* on the coastal side of the aircraft were considered un-surveyed.

Most of the search effort was 1.4 km offshore along the coast of northern Cook Inlet (north of Point Possession and North Foreland). The goal was to search all nearshore, shallow waters where belugas are typically seen in summer (Rugh et al. 2000). The trackline distance from shore was monitored with an inclinometer, keeping the waterline 10° below horizontal when the aircraft was at the standard altitude of 244 m (800 ft). Ground speed was approximately 185 km/hr (100 knots). The survey included searches up rivers until the water seemed to be very shallow or a distance recommended by Alaska Native beluga hunters who surveyed with us in the past (Rugh et al. 2000). Surveys were conducted daily during low tide when possible.

The location of each whale group was established by recording a GPS position while flying directly over the group. The flight pattern used to count a whale group was an extended oval around the longitudinal axis of the group with turns made beyond the ends of the group. Whales were counted during each pass down the long axis of the oval with observers and cameras on the left side of the aircraft. Counts began and ended on a cue from the front observer, starting when the leading edge of the group was close enough to be counted and ending when the trailing edge went behind the aircraft wing. This method gives an accurate record of the duration of each counting pass. Quality of each counting pass was a function of how well the observers saw the location of a group, not how many whales were at the surface. Ratings were A (if no glare, whitecaps, or distance compromised the counting effort) through F (if it was not practical to count whales on that pass). Only quality A and B ratings were used in the analysis. Although whale tracks were sometimes seen at the surface in muddy water, only whales at the surface during a counting pass were included in the counts. The daily aerial counts are represented by medians of each observer's median counts on multiple passes over each whale group (Table 1). The process of using medians instead of maxima or means reduces the effect of outliers (extremes in high or low counts) and makes the results more comparable to aerial surveys that do not include repeated passes over whale groups. Medians are also more appropriate than maxima when counts are corrected for missed whales because correction factors should be applied to the most representative counts, not the most extreme.

We used paired Sony HXR-NX5U HD video cameras to film each group of belugas. One camera was set at wide angle to capture a view of the entire group, and the other camera was zoomed to magnify individual whales in the group. The zoomed video is used to determine correction factors for missed whales (see Hobbs et al. 2000b) and to examine color ratios of white relative to gray belugas (Litzky 2001; Sims et al. 2003). The paired cameras were operated on all counting passes when group sizes were estimated to be up to 10 whales. Video footage from the cameras will be analyzed in the laboratory to obtain more accurate counts of belugas and the relative proportions of white versus gray versus dark gray (calf) whales.

As in August 2009 and 2010, we coordinated our counting efforts with LGL's boat-based photo-identification project with added

Table 1. Beluga whale estimates made during aerial surveys of Cook Inlet in August 2011. Counts are medians from observers doing multiple counts of each whale group. NS indicates area not surveyed, * indicates see text for details. Sites are listed clockwise around Cook Inlet starting with Turnagain Arm.

Location	8/9	8/10	8/11
Turnagain Arm	0	0	0
Chickaloon Bay/ Point Possession	0	0	0
Point Possession to Beluga River	NS	0	0
Beluga River	0	0	0
Ivan River	0	0	0
Susitna River	158	*	*
Little Susitna River	37	41	*
Knik Arm	9	25	55
Fire Island	0	0	0
Totals	204	*	*

coordination with joint base Fort Richardson-Elmendorf crews. The coordinated counting efforts included our surveying, counting, and video-taping a beluga group then directing the different photo-id teams and their boats to the group to begin photo-id effort after we departed the area to find additional beluga groups.

Results

The surveys (12 hours total) covered all coastal areas north of Point Possession and Beluga River (Figs. 1-3). All flights on 9, 10 and 11 August 2011 (3 take-offs and landings, flight time ranged from 3.5 to 4.6 hours) were based out of Anchorage International Airport. Of the 12 flight hours, 6.3 hours were spent on effort (i.e., not including time spent taxiing on the runway, deadheading without a search effort, circling whale groups to conduct counts, or periods with poor or useless visibility). Viewing conditions were ideal during most of the surveys. *Poor or useless* visibility conditions (determined by the primary front observer) only interfered with the survey effort during 0.105 hours (1.0% of the effective search time). The three observers (authors of this report: KEWS, CLS, & LVB) have participated in this project on previous surveys.

The aerial surveys in August 2011 covered the entire coastline in northern Cook Inlet for most waters within 3 km of shore. On 9 August, the survey began by crossing the inlet from Anchorage to North Foreland then following the coastline northeast, surveying up Beluga River, Little Susitna River, Knik Arm to Goose/Eagle Bay, circling Fire Island then following the coast along Chickaloon Bay into Turnagain Arm as far as Bird Point, back to Chickaloon Bay, entering Chickaloon River, continuing up the coast to Point Possession (Fig. 1).

Belugas were found between the Susitna and Little Susitna Rivers (median counts = 13 and 158, 9 video and counting passes of each group), in the mouth of the Little Susitna River (median count = 19, 8 video

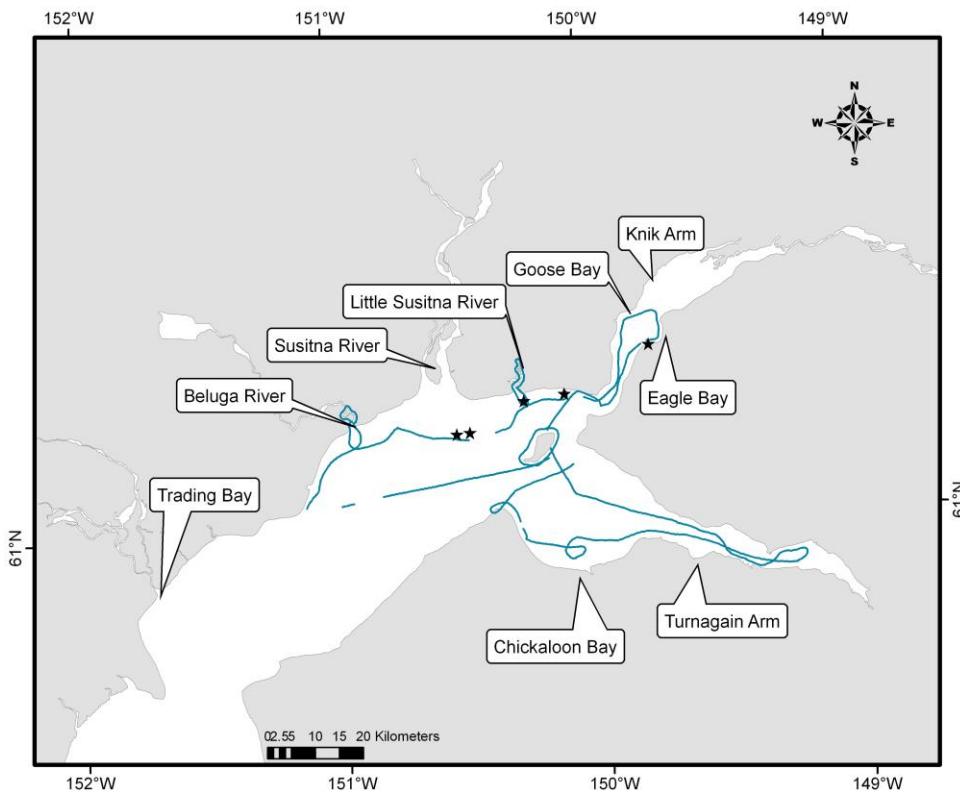


Figure 1. On-effort tracklines and beluga sightings for upper Cook Inlet survey on the 9 August 2011 flight. Note that the black stars represent the exact marks over the beluga group during counting and video-taping passes.

and counting passes), between the Little Susitna River and Point Mackenzie (median count = 18, 4 video and counting passes – aborted due to air traffic), and in Eagle Bay, Knik Arm (median count = 9, 4 video and counting passes). The total median count for the day was 204 beluga whales. Conditions were good to poor with rain squalls and low cloud cover.

On 10 August, we flew Knik Arm on the falling tide then followed the shoreline to Fire Island before crossing the inlet to the Susitna region, backtracking to Little Susitna River then revisiting Susitna before heading to Beluga River, crossing to Fire Island then following the shoreline into Turnagain Arm, then Chickaloon Bay to Point Possession (Fig. 2). Group 1 was in Eagle Bay (median count = 25, 9 video and counting passes). As we left Eagle Bay we contacted the Fort Richardson/Elmendorf boat crew who then headed into Knik Arm. As we crossed from Fire Island to Susitna we encountered two groups between the Little Susitna and Susitna Rivers that eventually merged into one group (median counts = 146 and 87, 7 and 6 counting and video passes, respectively, before the groups merged, then 6 video passes filmed through the open belly port). There was also a single whale offshore swimming toward the merging groups (included in the median count). We backtracked to the Little Susitna River and found a group west of the river mouth (median count = 41, 5 video and counting passes). We contacted the LGL boat crew, who were waiting near

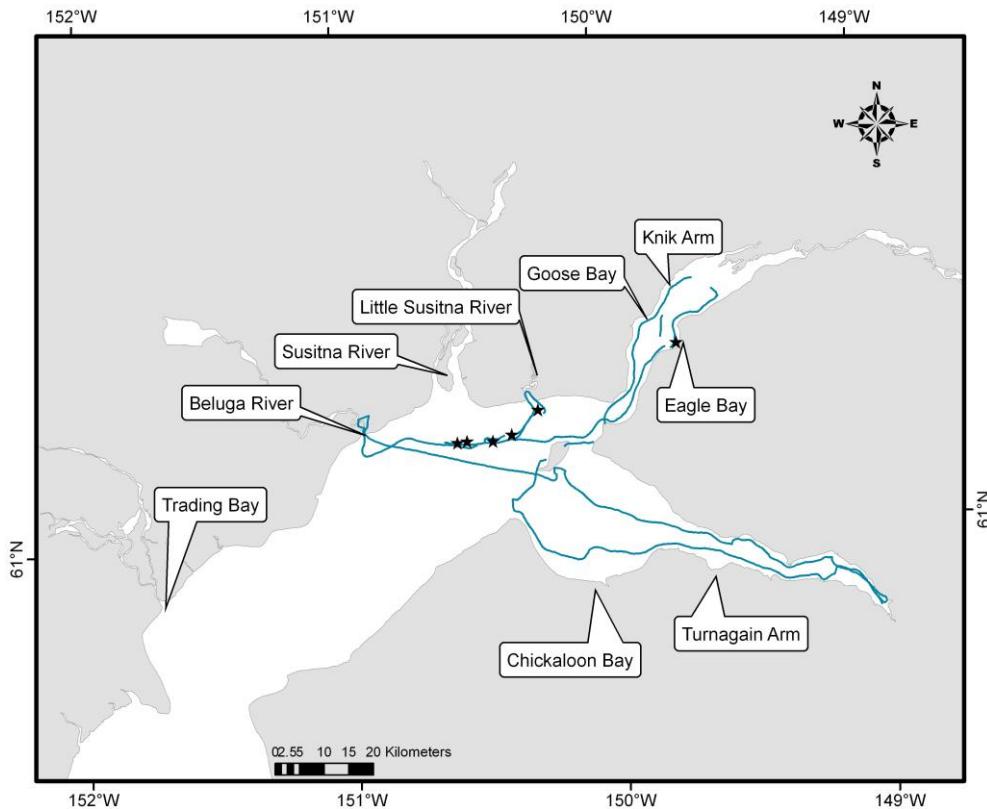


Figure 2. On-effort tracklines and beluga sightings for upper Cook Inlet survey on the 10 August 2011 flight. Note that the black stars represent the exact marks over the beluga groups during counting and video-taping passes.

Fire Island, directing them to the Little Susitna group. We returned to the Susitna region, passing one large group we thought might be the merged groups filmed earlier. We then encountered two groups approaching the first group from the east about 3.2 km (2 mi) from the earlier Susitna sighting. We were not sure if these were indeed new groups, because all whales observed in the Susitna region were traveling (swimming rapidly in a uniform direction) when observed and we were not sure if the whales could have covered the 3.2 km distance during the time (about 20 min) we were at the Little Susitna

River. Video and counting passes (6 total per the two eastbound groups) were obtained presuming the groups were new until further analyses could be conducted. Belugas were not seen elsewhere in the inlet. Conditions were fair to excellent with clear skies, calm winds and some glare.

After reviewing the data, it was determined that we couldn't be 100% sure that the eastbound Susitna groups hadn't separated from the groups seen earlier that day near the east tributary of the Susitna River. In general, beluga whales are slow swimmers. They commonly swim about 3 to 9 kph (1.9-5.6 mph). They are also capable of sustaining a maximum speed of 22 kph (13.6 mph) for as long as 15 minutes (Sattler 1987:60). Even at a normal swim speed of about 9 kph, the groups could easily cover the 3.2 km distance from the earlier sighting. Analyses of beluga whales equipped with satellite transmitters in Cook Inlet show whale swim speeds of 1-3 m/s (Ezer et al. 2008), which would cover roughly 2.4-3.6 km in 20 minutes. Therefore, we were not able to rule out whether we had encountered these groups (or parts of these groups) earlier in the day, therefore, an overall median count for the day was not calculated.

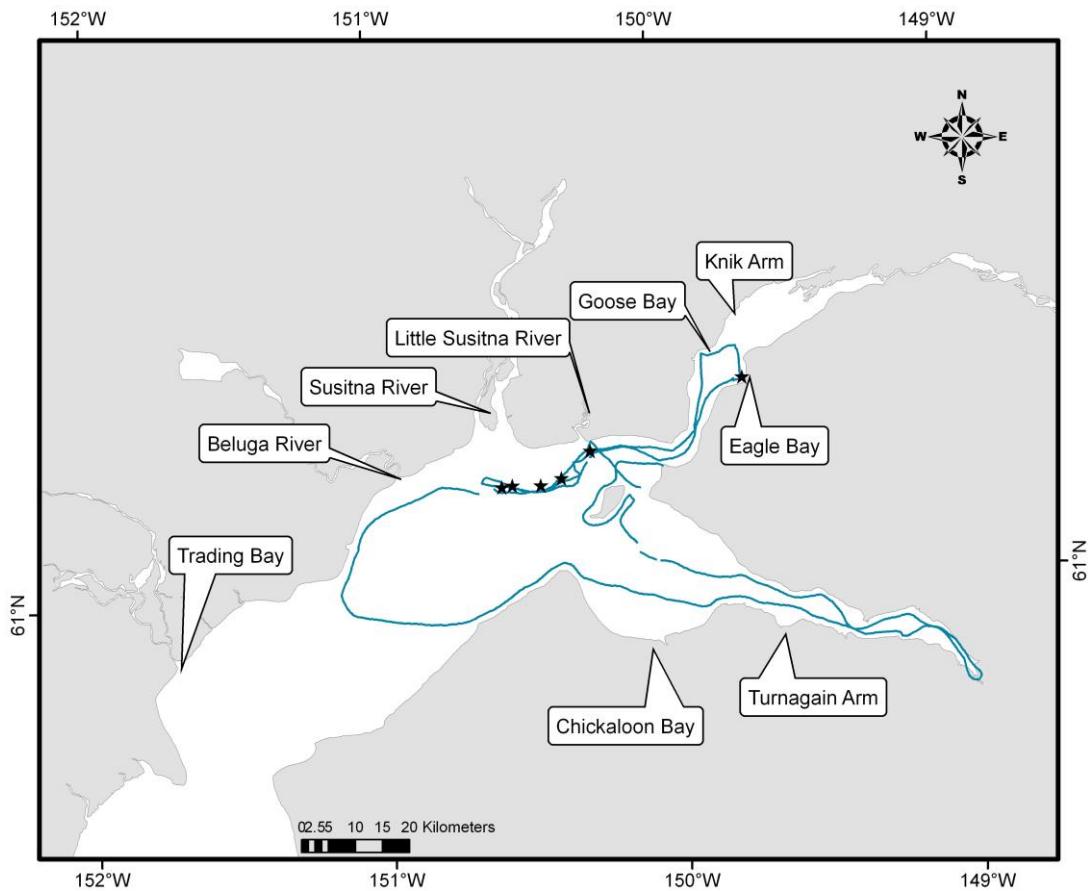


Figure 3. On-effort tracklines and beluga sightings for upper Cook Inlet survey on the 11 August 2011 flight. Note that the black stars represent the exact marks over the beluga groups during counting and video-taping passes.

On 11 August, we conducted a clockwise survey of the inlet north of Moose Point and North Foreland to coincide with the low tide in the Susitna delta. The survey began at Fire Island followed the shoreline into Turnagain Arm to 22-mile Creek, returning to Chickaloon Bay and rounding Point Possession, crossing the inlet between Moose Point and North Foreland. The coastal survey continued north into Knik Arm (Fig. 3). We coordinated our efforts with the Fort Richardson/Elmendorf boat crew in Knik Arm once again. Similar to the previous day, beluga groups were swimming rapidly eastbound along the mudflats of the Susitna River (6 video and counting passes of three groups), milling west of the mouth of the Little Susitna River (5 video and counting passes), swimming east between the Little Susitna and Point Mackenzie (4 whales, no video), and in Eagle Bay (median count = 55, 8 video and counting passes). Median counts of the larger groups were potentially compromised by whale behavior (i.e., rapid swim speeds, multi-directional surfacing), therefore, a total median count for the day will await analyses of the video. No whales were seen in Chickaloon Bay or Turnagain Arm. Groups were video-taped and counted as they were encountered without backtracking to avoid potentially recounting groups (as may have occurred on 10 August). Sighting conditions were fair to excellent with calm winds, clear skies and some glare.

Harbor seals (*Phoca vitulina*) were the only other marine mammals observed during the August 2011 survey (Fig. 4). Seals were hauled out on the mudflats Susitna River ($n = 60$ on 9 August, 67 on 10 August, and 18 on 11 August), and the river bank at Little Susitna River ($n = 32$ on 10 August). One seal was also observed in the water by the mouth of the Beluga River on 10 August.

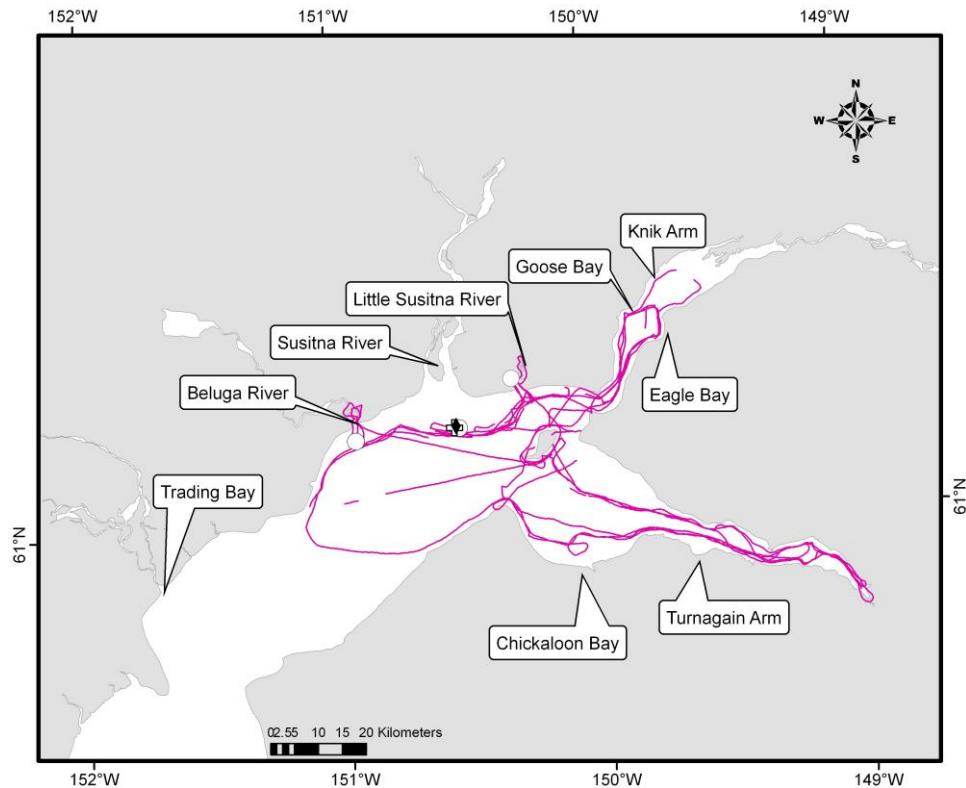


Figure 4. All on-effort tracklines flown during the August 2011 survey (red lines) with daily harbor seal sightings (white crosses = 9 Aug., white circles = 10 Aug., and black diamonds = 11 Aug.).

The median count (an index of relative abundance not corrected for missed whales) of 204 was similar to counts documented during the 2005-2010 August surveys (Fig. 5). The August 2011 count was within the range of daily median counts obtained in June 2011 (129 to 208 belugas, Shelden et al. 2011).

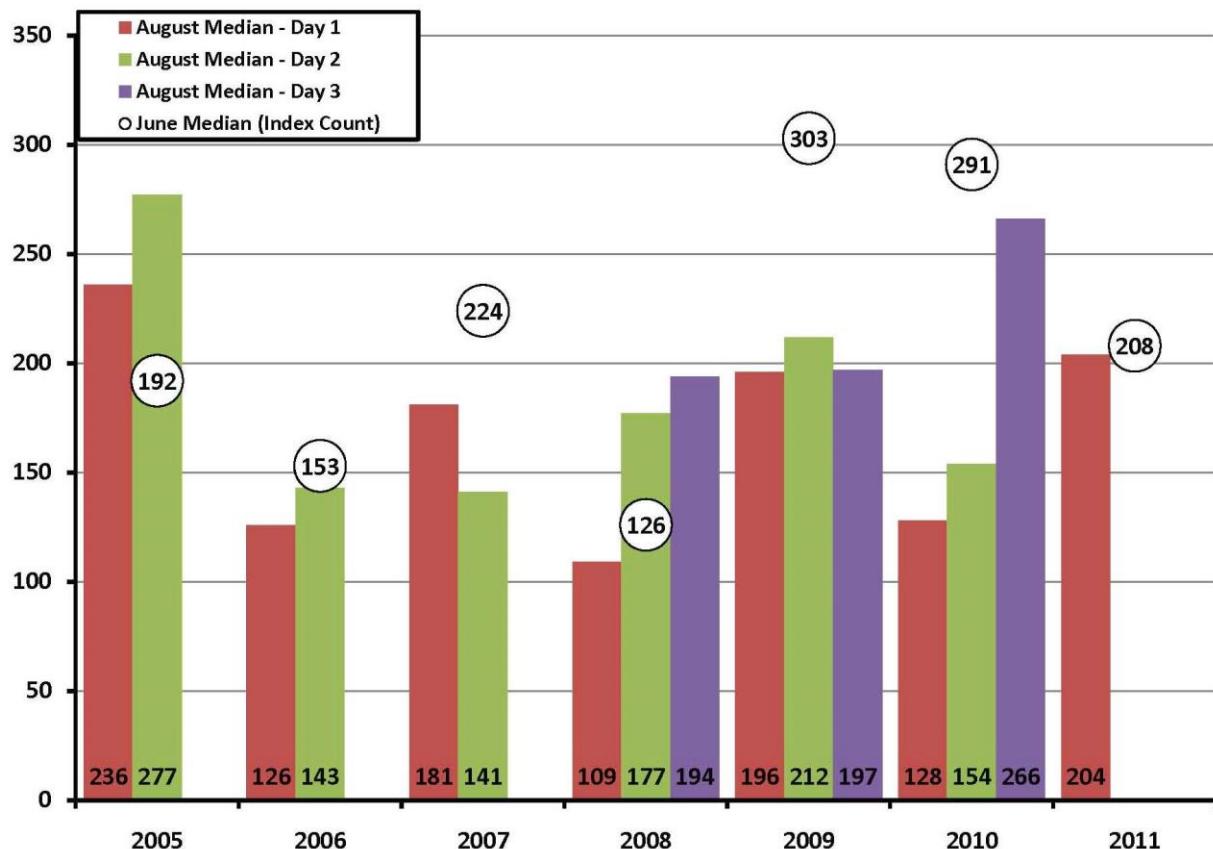


Figure 5. Daily median counts obtained during August aerial surveys of Cook Inlet belugas compared to the June index count (highest daily median count), 2005-2011.

Discussion

The primary goal of the surveys in August 2011 was to use paired HD video cameras to document beluga groups for analysis of age structure (white relative to gray individuals and dark gray calves) at a time when most calves have been born. This was consistent with the goals of surveys made in August of 2005-2010 (Rugh et al. 2005b, 2006, Shelden et al. 2007, 2008, 2009, 2010). Further analyses of the data will determine if there are any differences between the ratios of calves (small, dark whales) to

adults (large, white whales) in June versus August. This ratio will be important in assessing the reproductive potential of this *endangered* beluga stock. Results from this study and the joint aerial and LGL and Fort Richardson/Elmendorf boat-based surveys will be presented in a separate document after analyses of video and photographs are completed.

The August 2011 aerial survey of Cook Inlet continued the time series documenting the distribution of belugas in months other than June, and supplemented information gathered in 2000 and 2001 (Rugh et al. 2005a). Although the survey area in August 2011 was limited to northern Cook Inlet, this coverage is considered sufficient for examining beluga distribution for calf ratios because there have been consistently low sighting rates south of the Forelands (lower Cook Inlet) for more than a decade (Rugh et al. 2000; 2005a, 2010). Groups of belugas were seen from the Susitna River to Point Mackenzie and in Knik Arm. No belugas were found in Chickaloon Bay though survey conditions were mostly good. The absence from Chickaloon Bay was consistent with results from past August surveys (Rugh et al. 2005b, 2006, Shelden et al. 2007, 2008, 2009, 2010). The median count of whales in August 2011 was slightly below the index count (highest daily median count) in June 2011 (Fig. 5), which is also similar to August surveys in 2006, 2007, 2009, and 2010. Though, the opposite occurred in August 2005 and August 2008 (Fig. 5). There was no substantial difference in the distribution of belugas in upper Cook Inlet between June and August.

Acknowledgments—Rod Hobbs, Task Leader for the Cook Inlet beluga studies, helped coordinate funding for this project. Our pilots in August 2011 were Andrew Harcombe, Baine Thorn, and Eric Seller of Clearwater Air, Inc.; they filled a critical role in keeping the aircraft at the preferred altitude and distance from shore when flying intricate patterns over moving whales and watching for aircraft in an exceptionally busy airspace. Data entries were made on a program developed specifically for this project by Niel Goetz and Kimberly Goetz. This study was conducted under MMPA Scientific Research Permit No. 14245.

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Cite as:

Shelden, K.E.W., L. Vate Brattström, and C.L. Sims. 2011. Aerial surveys of belugas in Cook Inlet, Alaska, August 2011. NMFS, NMML Unpublished Field Report. 10 p.